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| Regarding | | Task E. Operation and Maintenance of Stormwater Harvesting and Use Systems DRAFT | | |

Includes all edits from team members: August 9 version

Future hyperlinks to other Harvest and Use Manual Sections or outside reports are in [brackets].

# Overview of Operation and Maintenance of Stormwater Harvesting and Use Systems

While many stormwater systems are designed to be relatively passive with minimal oversight needed, harvesting and use systems require managed operation where the goal is to move water from the storage unit to a point of use so that there is sufficient storage available to receive runoff from subsequent rainfall events. The timing and management of the water storage and use operation needs to be integrated into the system design. With an actively managed operating system, regular maintenance is also important to preserve the end use water quality, maintain system safety and efficiency, and minimize costs associated with repairs and downtime.

## Operation and Maintenance Agreements

Stormwater harvesting and use systems rely heavily on being properly operated and maintained and therefore having a formal agreement in place upfront is critical. An operation and maintenance agreement should:

* clearly state the responsibilities of the owner in operating and maintaining the system,
* describe the technical ability of the owner to perform the operation and maintenance,
* verify that a third party providing O & M services is approved by the city (or other local jurisdiction),
* identify which O & M activities need to performed by a licensed plumber, if any,
* address how the transfer of responsibilities will be managed should ownership change in the future, and
* provide for an on-going Operation and Maintenance Plan as described below.

## Operation and Maintenance Plans

In general, stormwater harvesting and use O & M plans should include the following items:

1. Site plans showing:
   * Location of system components
   * Maintenance access points for all functional elements of the system
   * Location and type of all operational controls (pumps, valves, sensors, etc.)
   * Location of underground utilities
2. As-built drawings showing:
   * Layout of pipes
   * Location of all controls
   * Location and type of all components that require periodic replacement (e.g. filters)
3. Operation and troubleshooting guidelines for system controls including:
   * Distribution systems (pumps, valves, sensors, etc.).
   * Treatment systems (monitoring requirements, dosages, etc.)
   * Overflow and bypass systems (valves, water level sensors, etc.).
   * Applicable regulations
4. Statements describing when a licensed/certified professional is needed for repair or maintenance of tanks, pumps, pipes, controls, or other components.
5. Description and schedule of inspection activities for all system components including
   * Spring start-up and winter decommissioning
   * Regular inspections – annual, seasonal, monthly, etc.
   * Inspection guidelines for special circumstances (very large runoff events, electrical outages, etc.)
   * Safety protocols to be followed during inspection
6. Description and schedule of maintenance activities for all system components including
   * Spring start-up and winter decommissioning
   * Regular maintenance – annual, seasonal, monthly, etc.
   * Replacement schedule for control elements of system (rain sensors, level loggers, pumps, etc.)
   * Safety protocols to be followed during maintenance
7. Manufacturer’s literature for all controls, replaceable components, and prefabricated components (pumps, sensors, treatment components, prefabricated storage units, etc.).
8. Component-specific O&M plan details
   * Collection surfaces
     1. Sweeping schedule for paved surfaces
   * Collection and pre-treatment system
     1. Instructions for correct operation of any manual valves
     2. Location and type of filters
     3. Location of debris collection sumps
   * Storage system
     1. Cleaning schedule
     2. Statement describing the method and frequency of water level monitoring
   * Treatment system
     1. Point of use water quality criteria/standards
     2. Schedule of required water quality monitoring
     3. Inspection schedule for all treatment components, per manufacturer’s guidelines
     4. Schedules for cleaning of filters, replacement of chemicals, etc.
     5. Safety protocols including special or hazardous materials handling
     6. Requirements regarding how long a storage unit should flush out in the spring before irrigation or other end uses begin so high chloride levels don’t kill vegetation or corrode metal components
   * Distribution system
     1. Instructions for correct operation of any manual valves
     2. Required color coding or labeling of pipes carrying harvested water
     3. Backflow preventer maintenance and inspection requirements
   * Irrigation system (if applicable)
     1. Controller programing guidelines
     2. Irrigation map showing application rates appropriate for soils/plantings
     3. Any Material Safety Data Sheets (MSDS) that are relevant for operation
     4. Inspection requirements for all components of the system
     5. Assumption used in sizing the system
     6. Applicable laws, codes and permits
9. Monitoring Plan
   * Use rates should be monitored at least monthly for at least three years. This should be compared to the water budget analysis of the design to determine whether the modeled level of performance is being achieved.
   * Required water quality monitoring
10. Inspection forms/maintenance logs for all regularly scheduled inspection and maintenance activities.
11. Statements outlining the roles and responsibilities of all parties participating in the operation, monitoring, and maintenance of the system, including which party must follow up on items that are outside the normal operating procedures.

# Operation and Maintenance Considerations

Operation and maintenance plans will vary depending on the configuration and components of the harvest and use system. Operation and maintenance considerations are described by system component below. Guidelines for inspection and maintenance timeframes and activities are provided in Table 1.

## Collection Surfaces

Collection surfaces should be inspected to identify sources of contamination and determine maintenance needs. Source control of pollutants and large debris at collection surfaces improves the quality of harvested water and can also extend the maintenance life of downstream components by reducing sediment and associated pollutant loads delivered to conveyances.

#### Rooftops

* Rooftops should be kept free and clear of debris
  + Organic debris from trees (leaves, pollen, flowers, seeds, twigs, etc.) can degrade the quality of harvested water. Overhanging tree branches should be trimmed as needed to reduce these inputs.
  + Animal feces can degrade water quality. Any nests should be removed and measures to discourage animal activity should be implemented as possible.
* Rooftops should be kept in good repair
  + Roof material may degrade over time due to exposure to UV light, repeated freeze-thaw cycles or accumulated storm damage. This may negatively impact the quality of harvested water (TWBD, 2010).

#### Green Space

* Maintain healthy vegetation and minimize application of chemicals to protect water quality
* Monitor for land disturbance and provide erosion and sediment control

#### Paved Surfaces

* Residual de-icing chemicals, sand, and salt should be cleaned from paved surfaces prior to spring startup of the system
* Pavement should be swept regularly (generally once per month)
* Any spills on the pavement should be cleaned immediately and/or contained to prevent contamination of runoff collected in the storage unit

#### Effluent from Stormwater BMPs

For information on the monitoring and maintenance of stormwater BMPs see the [MN Stormwater Manual](http://stormwater.pca.state.mn.us/index.php/Category:Operation_and_maintenance).

## Collection System and Pre-storage Treatment Components

Collection systems should be kept free of debris to prevent clogging and should be inspected to identify leaks. Clogging decreases the capture efficiency of the harvest and use system and can result in flooding or damage to collection surfaces or upstream facilities. Debris that has built up in conveyances may act as a source of pollution in harvested water, increasing the burden on downstream water treatment components to meet end use water quality criteria. Leaks in the system also decrease the capture efficiency of the system and may cause damage to foundations or structures located near the collection system.

The primary function of pre-storage treatment components is to reduce sediment and adhered pollutant loads in harvested water. Since primary treatment components are designed to collect sediment, these components must be inspected and maintained to preserve sediment storage capacity and maintain functionality of the collection system.

Collection systems are often designed in a passive form using gravity, so operational needs are limited. If collection systems include pumps, then the needs would be similar for distribution systems.

#### Rooftop Collection Systems

* Gutter and downspouts can be damaged by high winds, ice dams, or intense storms. Additional inspection is recommended following very large storms or extreme conditions.
* Leaves, twigs, and other organic debris should be removed from screens at a minimum in the spring and fall, but additional cleaning may be required where there is significant tree canopy.

#### Ground Surface Collection Systems

* Ground surface collection systems should be inspected annually for debris accumulation and erosion and repaired as needed.

#### Pre-storage Treatment Components

* Sediment and debris accumulations in pre-treatment storage components should be monitored periodically during the first year of operation to determine the rate of accumulation and develop an appropriate sediment removal schedule.
* Joints and fittings which connect collection and pre-storage treatment components should be inspected annually to look for loose fittings and leaks.

## Storage Components

Collection, distribution, makeup supply, and overflow systems all interact with the storage unit in some capacity. For this reason, regular inspection and monitoring of the storage system is an important diagnostic tool for monitoring system function as a whole.

* Tanks should be inspected periodically during operation to monitor for growth of microorganisms, presence of mosquitos, or formation of sludge, since these conditions can degrade water quality or may pose a health risk.
* Sediment accumulation in tanks should be monitored monthly during the first year of operation to determine the rate of accumulation and expected cleaning frequency. If possible, design your system to prevent the tank from having to be cleaned
* If tank entry is required for inspection or repair, this work must be done by a licensed and trained contractor or otherwise qualified professional following all safety standards and regulations. Likewise, fiberglass tanks should only be repaired by authorized personnel (ARCSA, 2015). Tank systems can be designed using union disconnects and manways to access tank components. This will reduce maintenance costs and confined space entry permits.
* Water that is stored for extended periods of time in storage tank may acquire an odor, particularly if there is any organic matter, such as pollen, in the water. Tanks may need to be flushed periodically and disinfected to correct the problem (NCDENR, 2014). An alternative to disinfection which can kill the beneficial aerobic bacteria if present is to provide additional aeration to maintain a healthy tank system.
* Allow the system to overflow to other best management practices during extreme events.

#### Underground systems

Special consideration may be needed for underground systems

* Removal of sediment generally requires a vacuum truck.
* Repair of underground tanks should be performed only by a qualified professional.
* Tanks may crack if post-installation above ground loads are higher than load rating (equipment, vehicles) or if activities such as landscaping do not take into account the tank specification or limitations.

For additional information on inspection schedules and activities for underground systems see Section 3.5 of New York City’s [Guidelines for the Design and Construction of Stormwater Management Systems](http://www.nyc.gov/html/dep/pdf/green_infrastructure/stormwater_guidelines_2012_final.pdf).

#### Stormwater Ponds

For information on the monitoring and maintenance of stormwater ponds see the MN Stormwater Manual section on [operation and maintenance of stormwater ponds](http://stormwater.pca.state.mn.us/index.php/Operation_and_maintenance_of_stormwater_ponds).

## Post-storage Treatment System Components

Post-storage treatment systems generally include consumable components – filters, bulbs, chemicals – that must be periodically cleaned, replaced, or replenished to maintain the performance of the water treatment system. Maintenance considerations will vary depending on the number and kind of treatment components that are included in the system. Examples include cartridge filters, reverse osmosis filters, UV disinfection light bulbs, ozone disinfection, and chlorine disinfection. See Table 6.5 of the [Texas Rainwater Harvesting Manual](http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf) for additional information.

* Some treatment systems may require special training or certification for operation.
* Depending on the end use, it may be necessary to demonstrate compliance with water quality regulations or health codes through regular water quality monitoring at point of use.
* Some systems may use materials that require special handling and storage. In these cases Material Safety and Data Sheets (MSDS) must be available onsite.
* Any handlers of potentially hazardous material must have appropriate training (ARCSA, 2015).

## Distribution components

Monitoring, maintenance, and repair of pumps, pipes, and controls may require a certified or licensed professional. The O&M plan should outline the conditions under which a licensed professional is needed.

#### Pumps

Most often a problem with the pump and pressurized distribution system is due to associated components (water level sensor, valves, pressure tank, makeup supply, or automatic bypass) and not the pump itself (Despins, 2012). Problems with associated components might be diagnosed by evaluating the water level in the tank and operation of these components (Is the tank empty when it shouldn’t be? Is the makeup supply on or off when it shouldn’t be?).

Maintenance concerns will vary depending on the type of pump (e.g. submersible or non-submersible). Potential maintenance concerns for pumps include the following.

* Malfunction of dry run protection (level sensor or built-in dry run protection)
* Pump intake becoming clogged
* Microbial growth on filters at pump intakes
* Pressure tank not supplying sufficient pressure to keep the pump operating
* Pressure sensor not functioning properly
* Electrical connections

#### Pipes

* Maintain required coloring and labeling of pipes per plumbing codes (or other regulations).
* Pipes that are not fully winterized should be drained when the system is decommissioned for cold weather
* Inspection and repair of pipes may require a licensed technician or contractor.

#### Makeup Water Supply System and Backflow Prevention

Local regulations should be consulted regarding potential cross connections when combining rainfall runoff with potable water systems. In most cases, cross connections are not allowed and an air gap must be provided between sources to limit the potential for contamination of the potable water supply.

Automated make-up supply - faulty float switches or solenoid valves can cause the makeup water supply to be activated or shut-off when the action is not required.

## Overflow and Bypass Systems

Overflow must be monitored periodically after rainfall events to ensure the system is capturing events it was designed to capture. Overflows that are not functioning properly may cause erosion, flooding, or damage to control systems (makeup supply, pump controls). Specific issues include the following.

* Clogging or damage at overflow/bypass intakes will cause water to short-circuit the system which may result in damage to nearby structures.
* Overactive overflow/bypass systems may be an indication of maintenance needs upstream in the system, for example, a pump failure that is preventing the storage from being drawn down or storage capacity compromised by accumulated sediment

Additional information can be found in Section 6.5, Overflow provision and stormwater management, Management Guidelines, [Ontario Guidelines for Residential Rainwater Harvesting Systems](http://connectthedrops.ca/downloads/ONTARIO_RWH_HANDBOOK_2010.pdf).

# Inspection and Maintenance Guidelines

Table 1 provides a summary of general inspection and maintenance guidelines.

Table . General inspection and maintenance guidelines for stormwater harvest and use systems. Information was compiled from the sources listed in Resources for O &M section.

| **Component** | **Timeframe** | **What to look for during Inspection** | **Maintenance§** |
| --- | --- | --- | --- |
| **Source Area/**  **Collection Surface** | Annually | Changes in land use or land disturbance | Implement source control BMPs as needed to help meet pre-storage water quality targets |
| Pollution [hot spots](http://stormwater.pca.state.mn.us/index.php/Potential_stormwater_hotspots) |
| Damage to roofing materials | Repair as needed |
| Overhanging branches | Trim overhanging branches |
| Nests or other evidence of animal activity | Remove nests and implement additional measures to discourage animal activity |
| Monthly or as needed | General condition of pavement | Adjust street sweeping schedule as needed to maintain clean pavement |
| **Collection System** | Spring startup and fall | General condition of gutters, downspouts, and conveyances | Clean accumulated debris in fall prior to winter operations or seasonal shut-down, and as needed. |
| Debris clogging inlets, gutters, downspouts, and other conveyances |
| Evidence of leaks at junctions or along conveyances |
| After large storms | General condition of first flush and high-flow diverters (bypass system) | Repair as needed |
| Soil erosion or flooding along diversion flow pathways | Provide appropriate erosion control measures (rip rap, check dams, etc.) |
| **Storage System** | Spring start up | General condition of all storage system components | Clean, repair and replace as needed |
| Position and function of valves | Test per manufacturer’s guidelines |
| Function of operational structures and controls |
| Periodically following startup | Tank ventilation | Clean, repair and replace as needed |
| Excess soil moisture near tanks or other evidence of leaks | Repair leaks per manufacturer’s guidance |
| Growth of algae or microbes | Drain and clean tank per manufacturer’s guidelines |
| Intrusion of mosquitos or small animals | Implement appropriate pest control as needed |
| Monthly | Sediment level in tank or pond | Remove sediment when the tank sediment storage volume has reached 50% of capacity |
| **Treatment Systems** | Spring startup | General condition and function of all treatment system components | Conduct testing per manufacturer’s guidance  Clean and repair as needed |
| Twice per year | Clogging from accumulated dirt and debris in pre-storage treatment components | Clean as needed |
| Evidence of leaks from loose fittings, joints | Repair as needed |
| 3 times per year AND after each rain event that exceeds the design capacity of the collection system | Clogging of intake and filters in first flush diverters, especially during pollen season (filter clogging) | Clean and replace as needed |
| Monthly or as required | Performance of water treatment system | Test water quality at point of use and at other points in the system (outlet of collection system, in-tank) as required |
| Adjust treatment parameters to meet any water quality deficiencies |
| Per manufacturer specifications and as needed | Condition of replaceable components in the treatment systems (filters, cartridges, bulbs, etc.) | Replace/repair per manufacture’s guidelines and as needed. Typical UV treatment is annual and filters are started on a quarterly basis or when differential pressure drops. |
| **Distribution System** | Spring startup and fall | General condition of all distribution system components | Repair/replace as needed |
| Position and function of valves | Test per manufacturer's guidelines |
| Function of operational controls |
| Presence of leaks (test) |
| Function and performance of pump | Complete all startup inspection and operations per manufacturer’s guidelines |
| Monthly | Presence of biofilms or sediment accumulation on filters | Replace/disinfect as needed |
| Per manufacturer and as needed | Function of pumps and other control equipment | Test all control components per manufacturer's guidelines or as needed to diagnose problems in the system |
| **Overflow/**  **Bypass Systems** | Annual (above-ground)/  As needed (below-ground) | Clogging or damage at overflow/bypass intakes | Clean and repair as needed |
| Erosion of downstream receiving area | Stabilize erosion, repair overflow system as needed, check for failures in other upstream components |
| Proper pump control and operation | Repair and replace as needed |

§See also decommissioning and winter maintenance tasks in Table 2.

# Winter Decommissioning and Maintenance

Throughout Minnesota, temperatures can drop below freezing (0°C) during the winter months. If stormwater harvesting systems are not fully winterized to withstand seasonal temperature fluctuations, systems should be decommissioned before the cold weather season. Winter decommissioning also provides an opportunity to preform annual inspection and maintenance. Table 2 provides a summary of winter decommissioning and maintenance tasks.

Table . Typical winter decommission and maintenance tasks prior to spring startup.

| **Component** | **Typical decommissioning and winter maintenance tasks needed prior to spring startup§** |
| --- | --- |
| **Source Area/**  **Collection Surface** | * Clean residual de-icing material (sand, salt) from pavement prior to spring startup |
| **Collection System** | * Drain and disconnect conveyances to prevent freeze/thaw damage |
| **Storage System** | * Drain all water from above-ground outdoor storage tanks * Disconnect downspouts and/or pipe upstream of the tank to prevent rainwater/snowmelt from entering the tank during winter months * Disconnect electrical supply that controls equipment * Shut off makeup water supply to prevent water from entering the tank |
| **Treatment System** | * Drain and disconnect any pre-storage treatment devices that should be decommissioned during the winter * Decommission treatment system components per manufacturer’s guidelines |
| **Distribution System** | * Switch end use supply from harvested water to public water supply (if necessary) * Drain all water from pumps and conveyance to prevent freeze/thaw damage * Disconnect electrical supply to the pump and control equipment * Complete all recommended winter maintenance for pumps and controls |
| **Overflow/Bypass Systems** | * Drain and disconnect to prevent freeze/thaw damage |

§Winter decommissioning tasks may be system-specific. Follow manufacturer’s and/or designer’s guidelines.

# Tracking O & M

Record keeping is part of regular operation and maintenance. Record keeping is important for

* documenting the system history (parts replacement, maintenance activities, and other observations),
* demonstrating compliance with regulatory codes,
* evaluating system performance and the performance of various components, and
* evaluating the cost of operation and maintenance, including labor and replacement parts.

Because harvesting systems can be configured differently, there is no ‘one size fits all’ form for inspections. Inspection forms and maintenance logs that are suited to the particular context should be included in the O & M plan. Example forms for spring inspection and maintenance, regular monitoring and maintenance, and inspection following storm events are included in this section.

Inspection forms should include, at a minimum, the following information:

* Type of inspection (annual, seasonal, monthly, special conditions)
* Date of inspection
* Name and contact information of inspector
* Items to be inspected
  + criteria for passing inspection
  + maintenance to be performed at the time of inspection
* Record of inspection - pass/fail for each item on the list
* Record of maintenance performed during inspection
* Record of any problems noted during inspection and follow-up actions that are required

Maintenance logs should include, at a minimum, the following information:

* List of items which require regular maintenance
  + frequency of required maintenance
  + description of maintenance to be performed
* Record of maintenance performed
  + name and contact information of maintenance provider
  + date maintenance performed
* Record of any problems noted during maintenance and follow-up actions that are required

It may be helpful to include additional information from the O & M plan, such as replacement part type, manufacturer, or service provider contact information, on inspection and maintenance forms. Any actions required after inspection or maintenance must be brought to the attention of the system manager or party who holds responsibility per the operation and maintenance plan.

**Spring Inspection & Maintenance Form (Example)**

System: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Installer Contact: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Catchment Surfaces (roofs, pavement, etc)** | | | | **Completed** | | **Additional Action Required?** (Describe under follow-up items) |
| **Collection** | **Maintenance** | | | **By (Initials)** | **Date** |
| *Rooftop* | *e.g. remove debris, wash surface* | | |  |  | Yes / No |
| *Parking* | *e.g. spring sweeping* | | |  |  | Yes / No |
| *Green Space* |  | | |  |  | Yes / No |
|  |  | | |  |  |  |
| **Collection System and Pre-storage Treatment** | | | | **Completed** | | **Additional Action Required?** (Describe under follow-up items) |
| **Component** | | | **Maintenance** | **By** (Initials) | **Date** |
| *Gutters/gutter guards* | | | *e.g. remove debris and sediment accumulations* |  |  | Yes / No |
| *Downspouts* | | |  |  |  | Yes / No |
| *First Flush Diverter* | | |  |  |  | Yes / No |
| *CB Sumps* | | |  |  |  | Yes / No |
| *All* | | | *e.g. check joints and fitting test the system for leaks* |  |  | Yes / No |
| *etc.* | | |  |  |  | Yes / No |
|  | | |  |  |  |  |
| **Storage (Tank, Pond) and Distribution** | | | | **Completed** | | **Additional Action Required?** (Describe under follow-up items) |
| **Component** | **Maintenance** | | | **By (Initials)** | **Date** |
| *All* | *e.g. test for leaks* | | |  |  | Yes / No |
| *tank inlet* | *e.g. clean and free of obstruction* | | |  |  | Yes / No |
| *Tank* | *e.g. clean and in good repair* | | |  |  | Yes / No |
| *overflow outlet* |  | | |  |  | Yes / No |
| *etc.* |  | | |  |  | Yes / No |
|  |  | | |  |  |  |
| **Treatment System** | | | | **Completed** | | **Additional Action Required?** (Describe under follow-up items) |
| **Component** | **Maintenance** | | | **By (Initials)** | **Date** |
| *all* |  | | |  |  | Yes / No |
|  |  | | |  |  | Yes / No |
|  |  | | |  |  | Yes / No |
| *etc.* |  | | |  |  | Yes / No |
|  |  | | |  |  |  |
| **Distribution System** | | | | **Completed** | | **Additional Action Required?** (Describe under follow-up items) |
| **Component** | | **Maintenance** | | **By (Initials)** | **Date** |
| *all* | |  | |  |  | Yes / No |
| *pump* | | *e.g. (all start up per manufacturer's instructions)* | |  |  | Yes / No |
| *water level sensor* | | *e.g. test per manufacturer's instructions* | |  |  | Yes / No |
| *backflow preventer* | | *e.g.(testing per local codes and regulations)* | |  |  | Yes / No |
| *make-up supply* | |  | |  |  | Yes / No |
| *etc.* | |  | |  |  | Yes / No |

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| --- | --- | --- | --- | --- | --- |
| **Inspection Follow-up Items** | | | **Notifications Required**  (Installer, City, etc.) | **Action Completed** | |
| **Inspection Date** | **Component** | **Action Required** | **By (Initials)** | **Date** |
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**Treatment System Maintenance Log** (Example)

**System \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Installer Contact \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| **Change UV Light** | | **Change Rinse Filter** | | **Clean First Flush** | | **Check for Leaks** | | **Test for Bacteria** | | **(other water quality testing)** | |
| *Annually* | | *Quarterly or as needed* | | *Quarterly or after each rain* | | *Quarterly or after each rain* | | *(as required)* | | *(as required)* | |
| Initial | Date | Initial | Date | Initial | Date | Initial | Date | Initial | Date | Initial | Date |
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UV bulb type and supplier \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Rinse filter type and supplier \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

First flush filter type and supplier \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Water quality testing protocol *(O & M manual reference)*

Water quality testing lab contact \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Post-Storm Inspection Form** (Example) **Date of Inspection: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**System \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Installer Contact \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date of Rainfall \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Total Precipitation (inches) \_\_\_\_\_\_\_\_\_\_\_\_\_**

**Significant factors:** (wind, hail, previous precip, etc.) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Catchment Area** | **Inspection** | | **Initial** | **Follow-up Action Required?** |
| When | What |
| *Rooftops* | *As needed* | *Remove large debris, inspect for damage* |  | Yes / No |
| *Pavement Areas* | *As needed* |  |  | Yes / No |
| **Harvest System** | | | | |
| *Gutters and downspouts* | *As needed* |  |  | Yes / No |
| *Debris screens* | *As needed* | *Remove debris if blocked/clogged* |  | Yes / No |
| *First flush device* | *As needed* |  |  | Yes / No |
| *Bypass system* | *Design storm or larger* | *Bypass active or evidence of active bypass (Yes / No)*  *Evidence of scour/erosion:* |  | Yes / No |
| *Overflow system* | *Design storm or larger* | *Bypass active or evidence of active overflow (Yes / No)*  *Evidence of scour/erosion:* |  | Yes / No |
| *Tank water level* | *Design storm or larger* | *Confirm normal operation* |  | Yes / No |
| *Pump* | *Design storm or larger* | *Confirm normal operation* |  | Yes / No |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Inspection Follow-up Items** | | **Notifications Required**  (Installer, City, etc.) | **Action Completed** | |
| **Component** | **Action Required** | **By (Initials)** | **Date** |
|  |  |  |  |  |
|  |  |  |  |  |
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# References

Despins, Christopher. September 2012. *Guidelines for Residential Rainwater Harvesting Systems Handbook*. Canada Mortgage and Housing Corporation (CMHC). ISBN 978-1-100-21183-1.

North Carolina Department of Environmental Quality (NC DEQ). April 2014. North Carolina Stormwater BMP Manual, Chapter 25, Rainwater Harvesting. Draft document.

# Resources for O &M

1. Metropolitan Council. Fall 2011. *Stormwater Reuse Guide*, prepared by Camp Dresser & McKee, Inc. and others. St. Paul, MN.

* Toolbox I.1b - Ground Runoff Collection, Operation & Maintenance Plans
* Toolbox I.2 – Storage Systems, Operation & Maintenance Plans
* Toolbox I.3 – Treatment, Operation & Maintenance Plans
* Toolbox I.4 – Distribution, Operation & Maintenance Plans

1. Despins, Christopher. September 2012. Guidelines for Residential Rainwater Harvesting Systems Handbook. Canada Mortgage and Housing Corporation (CMHC). ISBN 978-1-100-21183-1.

* Section 1.5 - Rainwater catchment and conveyances, Management Guidelines
* Section 2.5 - Rainwater storage and tank sizing, Management Guidelines
* Section 3.5 - Rainwater quality and treatment, Management Guidelines
* Section 4.5 - Makeup water system and backflow prevention, Management Guidelines
* Section 5.5 - Pump and pressurized distribution systems, Management Guidelines
* Section 6.5 - Overflow provision and stormwater management, Management Guidelines

1. American Rainwater Catchment Systems Association (ARCSA). 2015. Rainwater Harvesting Manual, 1st Edition. Editor: Ann Audrey.

* Section 7-4.3 – Pipes and Fittings - Operation, maintenance and repair Considerations
* Section 10-4 – Above Ground and Underground Storage Tanks – Overview of installation and operation
* Section 11-4 – Small-scale Storage Tanks – Overview of installation and operation
* Section 12-4 – Large-scale Storage Tanks – Overview of installation and operation
* Section 13-4 – Pumps and Controls – Overview of installation and operation
* Section 14-4 – Sanitation and Water Treatment – Overview of installation and operation
* Section 15-4.3 – Irrigating with Rainwater – Operation, maintenance and repair Considerations

1. North Carolina Department of Environmental Quality (NC DEQ). April 2014. North Carolina Stormwater BMP Manual, Chapter 25, Rainwater Harvesting. Draft document.

* Section 25.6 - Maintenance

1. New York City of Environmental Protection (NYCDEP). July 2012. Guidelines for the Design and Construction of Stormwater Management Systems. Developed in conjunction with New York City Department of Buildings.

* Section 3.5 Operations and Maintenance for Subsurface Systems